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Ich bin ein Berliner*

D. J. M. Wright[1] and M. Boyce[2]

1) *Microbiology, Charing Cross Hospital and* 2) *Plastic Surgery, Royal London Hospital, London, UK*

Abstract

The contributions of early British colonial and German scientists to the elucidation of the nature of spirochaetes, are contrasted. Recently, after a lapse of nearly three-quarters of a century, there has been a revival of interest by German microbiologists in investigating the borreliae.

Keywords: *Borrelia*, history, Lyme disease, relapsing fever, review, spirochaete

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Corresponding author: D. J. M. Wright, Microbiology, Charing Cross Hospital, Fulham Palace Road, London W6 8RF, UK
E-mail: d.j.wright@imperial.ac.uk

*When J. F. Kennedy made his famous Ich bin ein Berliner speech, the German audience understood what he was trying to say and applauded but the punctilious German interpreter said 'I am a doughnut'. The audience laughed but Kennedy said as an aside, 'It is just a translator's quip'.

As Germans celebrate the 20th anniversary of the fall of the Berlin wall, German medicine has been firmly rehabilitated from the pall of the Nazi era. Achievements of the golden age of German scientific discovery of the 19th and early 20th century, so long ignored, are now recognized once again, as well as those of present-day German scientists. Nowhere is this more true than the sequence of early events that led to the discovery of the microorganisms causing relapsing fever.

The British perspective concentrated on Africa, when a potentially fatal tick-borne fever was first recognized by David Livingstone in Angola in 1857 [1]. In 1904, Ross and Milne [2] in Uganda and Dutton and Todd [3] in Eastern Congo, made simultaneous discoveries of relapsing fever caused by a spirochaete transmitted by the bite of a tick, Dutton dying of pneumonia while debilitated by relapsing fever. Just before these discoveries were made, Cook [4] described the first cases of relapsing fever, again in Uganda, but mistakenly presumed that the disease was transmitted by insect bites.

The Russians, on the other hand, felt that the importance of much of their work was not recognized in the West. They underlined the importance of Munch's human inoculation experiments with live spirochaetes (see below), the laboratory studies on the microbe at the University of St Petersburg (1876) [5] and the discovery by Sakharoff (1891) [6] of *Borrelia anserina* in sick geese found near railway stations along the Trans-Caucasian railway in Georgia. This spirochaete became the 'reference organism' for *Borrelia*, as it could be maintained by repeated subculture in serum [7].

Putting aside these Cold War attitudes, the history really began with Alexander von Humboldt, in his day a celebrated polymath, who compiled a compendium of 4500 plants, which he had collected on his travels. In 1829, he went on his travels again, but this time to central Russia, starting at the Neva and ending on the banks of the Yenesi River in Siberia. He was the first person to discover deposits of gold and diamonds in Russia. He took with him the young microscopist, Gottfried Ehrenberg, who emulated von Humboldt by collecting and codifying infusorians (aquatic protozoa) which, when he came to publish, included a novel species, which he termed spirochaetes.

In 1834, Ehrenberg [8] distinguished the spirochaete (spiral hair) genus as essentially different from spirillum, the spirochaete being a thread-like helical but flexible organism.

In this he differed from his teacher, Muller, who saw the same microbe but held that the microbe was inflexible.

Ehrenberg's original description of the type of organism *Spirochaeta plicatis* is worth citing:

"On the second of April 1832, [the microbe] was seen in the wintery waters of Berlin. This little animal appears as a very spirally long thread-like vibrillum, it is not rigid but very flexible. The thickness of the helix is seventy times the length of the whole organism with many helical loops. However, some seem shorter than others without being thinner. It can elongate without losing its helicalicity, but may lengthen to a straight line but soon reverts to a wave form, ultimately forming loops. It swims like a vibrio. There are no recognisable organelles. Its width is 1/1000 mm and length 1/18–1/12 mm."

Dujardin (1841) [9] definitively described the spirochaete's movements as undulating and rotating on its axis, as well as bending flexibly. He found that the rotational movement persisted in fluid for a considerable time.

In 1866, Obermeier [10], working in the Charité Hospital in Berlin, found that during the acute phase of louse-borne relapsing fever, spiral forms appeared in the blood of the sick patients, which vanished when the fever remitted. He arranged for his findings to be demonstrated to the assembled staff of the hospital, whose principal pathologist was the doyen of histopathology, Rudolph Virchow. Virchow pontificated that although the spiral forms might be causative of the disease, one could not rule out that this finding might be an epiphenomenon. He was supported in this latter supposition by Polebotnow and Wiesner [11], who thought that the spiral forms were part of the arterial wall that had become detached during the raging fever. Virchow proposed that, to make a final determination, an animal should be inoculated with the 'spiral forms' to see if this reproduced the disease. Unfortunately, for Obermeier, the only animal that can be infected with relapsing fever, apart from primates, is man. His animal experiments were fruitless. His research ground to a halt, as at this point the epidemic subsided. Obermeier could do no further experiments as he did not know how to maintain spirochaetes in culture. Virchow was prescient in foreseeing that transmissibility of infectious material was critical in deciding whether a microbe was responsible for an infection, some 16 years before Koch [12] enunciated this in his postulates. However, Virchow knew of Rayer's experiment in 1837 [13], which had shown that glanders was infectious by inoculating diseased tissue from a man with glanders into an uninfected horse, thereby transmitting and reproducing this disease.

Luckily, Obermeier kept his preparations of spiral forms and, in 1870, compared them with Ehrenberg's *Sp. plicatis*. The spiral forms were unequivocally pronounced to be spirochaetes, and the species was named: *Spirochaeta obermeieri.* In 1872, a relapsing fever epidemic returned to Germany and Obermeier [10] decided to prove the spirochaete's infectivity by inoculating the blood of an infected patient into himself, but was unaffected; however, he failed to determine if there were spirochaetes in the injected blood. He was pursued by bad luck, as he died of a septicaemia, after self-inoculation of blood from a cholera patient, when similarly trying to prove that cholera was infectious. The experiment to prove that spirochaetes were the infective agent of relapsing fever was finally carried out by Gregor Munch [14], who inoculated himself with a glass capillary containing the blood of a patient with relapsing fever. He promptly developed the fever but survived. Moczutkowsky, in 1873 [15] in Odessa, inoculated blood from relapsing fever patients into other non-infected patients in his ward and showed that they succumbed to the disease, with spirochaetes in their blood at the height of their fever. This discovery was hailed as a breakthrough, as this was one of the first microbes found to cause a disease, and was the impetus for research into other diseases caused by microbes.

In 1907, Swellengrebel [16], a Dutch bacteriologist, read in an article by Borrel [17], that the only spirochaete that was peritrichate was the spirochaete that caused tick-borne relapsing fever (a 'spirochaete' morphologically identical to that of Obermeier). This distinctive feature allowed the species to be renamed *Borrelia* and the relapsing fever microbe *Borrelia obermeieri.*† Again, even after death, Obermeier's bad luck followed him. *B. obermeieiri* was ultimately renamed after the nature of the disease it caused, as *Borrelia reccurentis*, the name of Obermeier being lost forever from the nomenclature. However, spirochaetale, spirochaetaceae and spirochaeta are preserved as the names variously of an order, family and genera, which include a variety of environmental spirochaetes.

Apart from Alfred Bannwarth [19], a Munich neurologist, who, during the Second World War, described a meningoradiculitis later found to be associated with borreliosis, the recent German contribution to spirochaetology has related mainly to Lyme borreliosis. Again from southern Germany, Ackermann [20] delineated Lyme encephalitis, while Kurtenbach's associates identified a new strain of *Borrelia burgdorferi* sensu lato, *Borrelia baveriensis* [21], and are remembered by the *Borrelia bissettii* variant *Borrelia kurtenbachii* [22]. Currently at the forefront of borrelial research is the study of pathogenesis, molecular biology and even ultrastructure by groups chiefly associated with Marcus Simon, Peter Kraiczy and Rein-

†It later turned out that this distinctive feature was an artifact caused by a too vigorous preparation of his slides, but the name *Borrelia* has persisted [18].

hard Wallich [23–26]. In this way, German spirochaetology has begun to regain the leading position it held at the turn of the 20th century.

Transparency Declaration

There were no conflicts of interest and both authors took part in the genesis of the paper.

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